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MODEL ATMOSPHERES FOR X-RAY BURSTING NEUTRON STARS

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MODEL ATMOSPHERES FOR X-RAY BURSTING NEUTRON STARS*

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Self consistent neutron star atmospheric models have been constructed which include the effects of Comptonization, free-free and bound-free absorption. It has been demonstrated that for parameters relevant to x-ray bursting neutron stars the atmosphere does not radiate like a blackbody during any phase of an x-ray burst. In particular, during the initial rise and final decline of the burst the temperature structure of the atmosphere is affected by backwarming associated with the high opacity due to free-free processes at low frequencies to an extent that the radiation spectrum is shifted to higher energies than a blackbody of the same effective temperature. On the other hand, near the peak of the burst, the opacity is more gray-like as the electron scattering opacity dominates; however, in this case thermalizaton of the radiation field occurs at such large optical depths ($\tau \sim 5$) that the spectral temperature is higher than the effective temperature. This result is found despite the importance of Comptonization in the thermalization process. Thus, the super Eddington fluxes implied by the spectral data alone are misleading and result from the improper use of the spectral temperature for the effective temperature. For neutron stars characterized by a soft equation of state and radiating near the Eddington effective temperature, fluxes obtained in this way could be overestimated by a factor of about 5.

Because the spectral hardening factor varies throughout an x-ray burst, deconvolution of the spectrum is required before definitive statements can be made concerning the variation of the size of the emitting region. We may say that because of the spectral hardening effect, radius determinations, based on the spectral temperature are only lower limits.

We have also found that the shape of the continuum can be affected by the presence of Fe in the atmosphere; however, the features from bound-free transitons in partially ionized Fe are not particularly strong in the non-LTE approximation for solar abundances.

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